UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF EMERGENCY WIRELESS COMMUNICATION SYSTEM BY USING GSM

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Telecommunication) with Honours.

by

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This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the Bachelor's Degree in Electronics Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follow:

……..

(MR. WIN ADIYANSYAH INDRA)

ABSTRACT

Earthquake is a unique disaster since there is no any warning before it strikes and it cause losses of human life and property. The emergency wireless communication system is very important to save the life and improve the rescue process. The SW-420 vibration module is used to detect the vibration. The output will turn high when the vibration detected is higher than the threshold value of vibration module. After the detection of vibration, the Light Emitting Diode (LED) and buzzer are turned on to alert the public and the emergency message will be sent out to the public. The Global System for Mobile Communication (GSM) technology is used to send Short Message Service (SMS) since GSM has wide coverage. Arduino Uno is used in this project as the microcontroller of the system. The output of vibration module is read by the Arduino and then the Arduino will turn on the LED, buzzer and also enable SMS sending from SIM900A GSM module. This system is able to establish a two-ways communication during an earthquake in order to deliver and get important information which is able to reduce the casualty.

ABSTRAK

Gempa bumi adalah bencana yang unik kerana tidak ada amaran sebelum ia menyerang dan menyebabkan kehilangan nyawa dan harta manusia. Sistem kecemasan komunikasi tanpa wayar adalah sangat penting untuk menyelamatkan nyawa dan meningkatkan proses penyelamatan. Modul getaran SW-420 digunakan untuk mengesan getaran. Keluaran akan berubah tinggi bagi modul getaran SW-420 apabila getaran dikesan lebih tinggi daripada nilai ambang modul getaran. Selepas pengesan getaran, Light Emitting Diode (LED) dan buzzer akan dihidupkan untuk memberi amaran kepada orang ramai dan mesej kecemasan akan dihantar kepada orang ramai. Teknologi Global untuk Komunikasi Mudah Alih (GSM) digunakan untuk menghantar Perkhidmatan Pesanan Ringkas (SMS) kerana GSM mempunyai liputan yang luas. Arduino Uno digunakan dalam projek ini sebagai mikrokontroler sistem. Keluaran modul getaran dibaca oleh Arduino dan kemudian Arduino akan menghidupkan LED, buzzer dan juga membolehkan penghantaran SMS dari modul GSM SIM900A. Sistem ini dapat mewujudkan komunikasi dua arah semasa gempa bumi untuk menyampaikan dan mendapatkan maklumat penting supaya dapat mengurangkan mangsa bencana alam.

DEDICATIONS

To my beloved parents

To my respected lecturers

And not forgetting to all friends

For their

Love, Support, Encouragement and Best Wishes

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

GSM	-	Global System for Mobile Communication
SMS	-	Short Message Service
TDMA	-	Time Division Multiple Access
GPRS	-	General Packet Radio Service
LED	-	Light Emitting Diode
SIM	-	Subscriber Identity Module
HLR	-	Home Location Register
VLR	-	Visitor Location Register
BTS	-	Base Transceiver Station
BSC	-	Base Station Controller
MSC	-	Mobile Switching Center

CHAPTER 1

INTRODUCTION

1.0 Background

Wireless communication is the transmission of information over a distance without the wires or cables. The transmitted distance can be anywhere from a very short distance to a very long distance. The wireless communication has the advantages of faster transmission and cheaper for implement and maintenance (Wei, Zeng & Shen, 2015).

Emergency wireless communication is a system that supporting one-way and two-way communication of emergency message. It plays important role when the wired communication cables are cut during disasters such as earthquakes.

Earthquake is the shaking of the surface of Earth due to the sudden release of energy that creates seismic waves (Hamilton, 2012). Earthquakes provide no warning before they strike and cause thousands life sacrificed due to the earthquake occurs in dangerous place or without effective warning system (Saradha, 2011). By theory, the P waves are the first wave attack then follow by the S waves which are stronger shake than P waves (Alphonsa & Ravi, 2016).

Emergency wireless communication is able to reduce damage caused by earthquakes and helps to save life by alerting public when the P waves are detected. In this project, GSM (Global System for Mobile communication technology) is chosen because it is a suitable technology to be used in emergency wireless communication system since all of the mobile phone users are likely to have GSM coverage. GSM is a digital mobile telephony system and it is widely used nowadays.

GSM with other technologies act important roles in the evolution of wireless mobile telecommunication (Rouse, 2007).

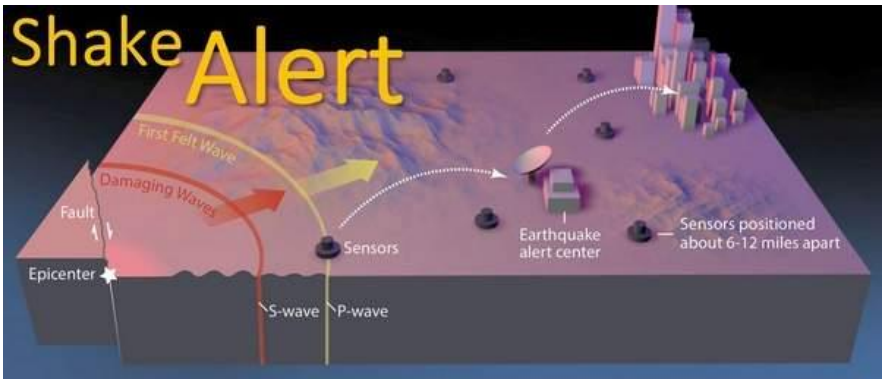

Figure 1.1: The earthquake alert system demonstrated by diagram

To complete the emergency wireless communication system, SW-420 vibration module and Arduino Uno is used in this project. Vibration sensor is able to generate voltage when a vibration is detected and it acts as an earthquake detector. The voltage generated is read by arduino and arduino is the microcontroller in the system. The emergency wireless communication system is able to provide early warning to the public and establish communication when the earthquake is detected. In this project, the emergency warning message will be sent to mobile phone of users when the vibration is detected by vibration sensor. The GSM module is able to receive the information via SMS service also.

1.1 Problem Statement:

Earthquakes are unique in natural disasters since there is no any warning before the earthquake strike. It is difficult to predict what time the earthquake will be occurred.

Every year thousands of people life sacrificed because of earthquake. This is because earthquake occurs in dangerous place or during sleep. Besides, the shaking will cause damage buildings or collapse. The communication system connected by wire and fiber can also be wiped out by earthquake or other disaster.

Although the earthquake occurrence is not a common problem in Malaysia, but it is possible to experience medium magnitude earthquake since Malaysia is located near to high magnitude earthquake area such as Sumatra and Andaman Sea (Borneo Post, 2013). The recent earthquake occurred in Sabah, June 2015 has caused loss of 18 lives and significant damage to properties.

The damage can be reduced or minimized and human lives can be saved if an emergency wireless communication system is able to apply since the emergency message will be sent out immediately during the primary wave. This helps to alert the public about the disaster and increases the chance to save human life and their important property. The emergency wireless communication is very important for rescue work also.

The warning signal can be transmitted by using satellite, fiber optic, GSM or the combination. The emergency wireless communication is suitable to be implemented in Malaysia also since there are some local earthquakes occurred in Sabah and Sarawak.

1.2 Objective:

The objectives of this project are:

1. To study the concept and operation of emergency wireless communication system during earthquake.
2. To develop an emergency wireless communication system that can support disaster or emergency management by using GSM.

The main objective in this project is to study the concept and operation of emergency wireless communication system during earthquake. The design of circuit and the equipment needed are studied though this project.

The next objective is to develop an emergency wireless communication which can support disaster or emergency management such as earthquake by using GSM.

GSM is the mobile communication technology that used to send emergency message by Short Message Services (SMS).

1.3 Scope

In this project, SW-420 vibration module will be used to determine the environment vibration. The output of the sensor, either high (vibration) or low (no vibration) is directly connected to Arduino which is able to read the voltage generated by the vibration sensor. The output will be high when the environment vibration is over the threshold value and the threshold can be adjusted by the potentiometer on the vibration module.

The vibration sensor is designed to be placed at the seaside to detect the vibration of earthquake. This project is using Arduino Uno as a microcontroller. Arduino Uno is a microcontroller board based on the ATmega328P.

SIM 900A GSM module will be used in this project to send emergency message. It has the frequency band of 900 MHz which is suitable frequency used in Malaysia.

The project scope is focused on the vibration detection and also the emergency message communication. This system can only detect the vibration beyond the threshold value of vibration module and establish a connection between disaster control centers, public and rescue team by SMS services.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Natural disaster occurs without prior warning and come along with the destruction of wired telecommunication infrastructure (Srinivasan, 2011). Emergency wireless communication system plays an important rule as the disaster warning and communication system.

In this project, the emergency wireless communication during earthquakes is focused. The operation and concept of SW-420 vibration sensor, GSM module and Arduino Uno will be studied and applied to this project in order to develop an emergency wireless communication that can support emergency management. Earthquake early warning systems are currently operating in several counties; it is used to alert people when shaking waves are expected to reach their location. This system is very important since earthquakes will cause serious damage and even lead to tsunami.

Emergency communication system not only provide warning message to public, it also establish communication between control center, people affected and also the rescue team.

2.1 Earthquake and its Effect

Natural earthquake is generated by the movement of earth's crust or tectonic plates. Although the movements of the earth's crust are quite slow but it can bring a dangerous effect of collision (Hoque, Hassan, Sadaf, Galib & Karim, 2015). Earthquakes always cause casualties and property loss and it is difficult to be

predicted by current technology. The destruction is caused by the sudden release of energy which is able to create seismic waves (Hamilton, 2012).

The unit used to determine the magnitude of earthquakes is Richter scale and the earthquake is determined by seismometer. The largest earthquake has been over 9 Richter scale and it is able to cause tsunami, landslides and liquefaction. The levels of damage depend on the amplitude and duration of shaking. The damage caused by earthquakes can be minimized by develop an effective emergency wireless communication system.

The immediate resilience after the earthquake is an important aspect worth being investigated since the emergency relief is the top priority. According to the Japan Kobe earthquake statistics, there are 60% buried people died after earthquake while 40% of them are still alive and waiting for rescue. The most critical component of successful rescue operation is time, but the disaster areas always cut off from outside due to traffic congestion and interruption. This causes the disaster rescue team cannot rush to the disaster are in short time. Therefore, the direct involve of residents is very important for emergency communication to reduce casualties (Han, Zhao, Yu, Guan, Peng, Li & Ou, 2016).

Figure 2.1: Cypress Freeway that collapsed during the 1989 earthquake

2.1.1 Malaysia's Earthquake Risk

Malaysia is not normally associated with earthquakes. West Malaysia is seismically stable although vulnerable to the effects of large earthquake in Sumatra. The Indian Ocean plate is pushing under Sumatra in the direction of Malaysia at the rate of 7cm per year. The large earthquakes occur in Sumatra cause buildings to shake in Kuala Lumpur and Johor Bahru. The Philippine plate is moving towards Malaysia around 8cm per year (The Thrifty Traveller, 2016).

According to the director of National Earthquake and Tsunami Center, Dr. Wan Azli Wan Hassan, the peninsular and East Malaysia have a lots of default zones which could cause moderate and weak earthquake since peninsular and East Malaysia are near to the Pacific Ring of Fire. Besides, Sabah located at the more active zone, which the moderate earthquakes between 5.0 and 5.9 on Richter scale could be occurred. The most active fault zone is Central-North (Ranau) which consists of nine fault lines and it is affecting Tuaran, Penampang, Tambunan and Ranau. The biggest record is a 6.2 magnitude quake in Lahad Datu in 1976 (My Sinchew.com, 2015).

After the earthquake in Sabah, there have been worries that an earthquake may also attack Kuala Lumpur. According to the Universiti Malaya Geology Department Associate Professor, Mustaffa Kamal Shuib, Kuala Lumpur is located near the epicenters of ancient fault line zones and these fault lines might be reactivated by the active tectonic plate boundaries. Based on the online new, Assoc Prof Mustaffa said that in recent years, there is evidence of earthquakes with focal points or epicenters are occurred due to the reactivation of old fault lines. The Peninsular Malaysia is at the center of the Sunda Shelf, also known as Sundaland. The Sundaland is absorbing all the pressures from surrounding. The earthquakes will occur when the earth has to find some release by breaking through the old fault line system (Today, 2015).

2.1.2 Seismic Waves

The magnitude of earthquake is determined by the reading of seismic which is the waves of energy caused by the sudden breaking of rock in the Earth. They are divided into two types, which are body waves and surface waves. The body waves arrive before the surface waves during an earthquake and have higher frequency. Body waves include P waves and S wave. P wave is the first kind of body waves and the fastest kind of seismic waves (Ammon, n.d).

2.2 Emergency Wireless Communication

In the past few years, the demand of wireless communication is increases steadily. Various techniques have been studied to improve the bandwidth, efficiency and also increase the number of users (Tripathi & Shukla, 2014).

Wireless communication is the transfer of information without connected by electrical conductor. In other word, wireless communication also means that the sending and receiving signal without physical wires. There are various wireless communication technologies. The examples are GSM, WiFi, Bluetooth, ZigBee, Infrared etc (Phogat & Anand, 2014).

Emergency communication and disaster recovery system are important issue in communities throughout the world. Because of emergency communication system has to be fast and flexible, wired communication technology is not suitable (Nguyen, Gyoda, Okada & Takizawa, 2007).

Wireless communication gain attention due to easy implementation, suitable for public safety and communicating in emergency situation or disaster. Emergency communication system include two-way communication between emergency communication staff, affected people and first responders, it provide detailed and meaningful information. Emergency wireless communication should be capable of

monitoring sensitive areas and enable communication immediately after a disaster (Chiti, Fantacci, Maccari, Marabissi, Tarchi, 2008).

Risk communication needs the commitment to listen, understand and learn from audience. This is because the emergency communication is not only to send message, but to inform about the danger posed by certain facility. The prior preparation of the emergency response is needed to improve the emergency management. The information provided during emergency is very important since the more information and knowledge we have, the more the public will know the way to protect themselves in emergency situation (da Cunha & de Andrade, 2016).

Emergency communication during disaster is important to improve rescue process and reduce casualties since this system is able to provide useful information such as location and details of the disaster (Han, Zhao, Yu, Guan, Peng, Li & Ou, 2016).

There are some different between communication system and notification. Communication system is not only inform the public about disaster but it is able to provide detail information and enable 2 ways communication between the disaster information center, people related and the rescue team.

The emergency wireless communication today uses satellite communication due to the high capability. Satellites are not susceptible to damage from disaster since the transmitter and receivers are located outside the Earth's atmosphere (Hartshorn, 2016).

In this project, vibration module, GSM module and Arduino are used to simulate a simple emergency wireless communication system. GSM module is used to send and receive message when the earthquake is detected by the vibration module.

2.3 Technologies Recommended for Disaster Relief in Future

The existing technology such as Professional Mobile Radio (PMR) is able to support data communication during disaster, but the networks will be easily